Educational Module

Title: Soil Characterization

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Grade Level/Subject: 8th & 9th grade Earth Science: 90 minute class periods

Curriculum Standards: (Adapted from National Science Education Standards)

Content Standard A:

- Abilities Necessary to do Scientific Inquiry
  - ✓ Identify questions and concepts that guide scientific investigations.
  - ✓ Design and conduct scientific investigations.

Content Standard B:

- Chemical Reactions
  - ✓ A large number of important reactions involve the transfer of either electrons or hydrogen ions between reacting ions, molecules, or atoms.

Content Standard F:

- Natural Resources
  - ✓ Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.
- Environmental Quality
  - ✓ Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients.
  - ✓ Materials from human societies affect both physical and chemical cycles of the earth.

Overview:

In this lesson/laboratory experience, the students will investigate the characteristics of different types of soil. Students will first begin the KWL project and then, through a led discussion, determine ways to characterize soil based upon pH and physical characteristics. Upon characterization of their respective soils, students will have investigated how each of the four factors effects characterization of soil.

> **KWL**: What We **Know**; **Want** To Know; What We **Learned**
> This project can start at the beginning of a unit, or lesson, as in this case. The class makes a list with three categories; **K, W, L**; listing under each category objectives, facts, or other concepts. To begin with, students generate items under the **K** column. Items under the **W** column are generated by teacher/student discussions, and also serve as a way to give students some level of ownership for what they are responsible to learn. Upon completion of the module, the class generates items to be listed under the **L** column. This serves as a closure activity for the lesson/laboratory. A master **KWL** is kept in the classroom where everyone can see it, and it is updated when necessary. Each student is responsible for keeping an updated version of the **KWL** in his or her notebook.

Purpose:

Upon completion of these experiments students will hopefully gain an understanding of how and why soil is characterized based on physical and chemical properties. More importantly they will be involved in experiment design, presented with an opportunity to experience a real-life application of science, and an introduction to professional applications of soil characterization.

Learning Objectives:

After the completion of this activity, along with the **KWL**, the learner will:

- Characterize soil using a soil classification triangle.
- Know the role and effect of each of the four components of soil.
- Understand how percolation is affected by physical characteristics of the soil.
- Be able to determine the pH of a soil sample using various techniques.
- Have a better understanding of how experiments are designed by scientific inquiry.
- Have a new insight into professional applications of science.

Materials and Equipment:

electric pH meter (if available)	stopwatches
pH strips	tin cans w/ ends removed
medium glass jars with lids	tape
100ml-graduated cylinders – 1 per person (if available)	de-ionized water
rubber stoppers for graduated cylinders	tin snips

Student Prior Knowledge Necessary for Success:

Before students begin this exercise they should have sufficient background knowledge in the following areas:

pH scale	density
acidic soil	soil pH scale
alkaline soil	

By using the KWL strategy, student prior knowledge can easily be assessed and preparatory lessons can then be modified. The purpose of this activity is to provide students with a real life scenario concerning soil sciences. It should follow lessons concerning these topics listed above and items that do not appear on the "K" list, but teacher discretion is always advised.

TENTATIVE LESSON SCHEDULE

FIRST DAY: ½ OF A DAY
Unit Introduction (30min)

- Today's objective is to introduce soil science and begin the **KWL** project. Topics should include:
  - Brief characteristics of each of the four fractions of soil
    - Clay, sand, silt, organic matter
  - Professional applications of this type of science
    - Examples of different professions related to soil science
- A few days before this activity begins; assign students the task of collecting 2 cups of soil from any location they choose and bringing it to class in a clear glass bottle (canning jar sizes work best). The students will fill out an observation worksheet while they collect the soil.
- Experiment outline handed out to each student.
- Remind student who have not brought in soil samples to do so TOMORROW!

Class KWL Discussion (20min)

- KWL sheets maintained by the students should be handed out.
- During a class discussion, students will generate ideas or items they know about soil, completing the **K** column.
- Next, through a teacher-led discussion, items for the **W** column will be generated. By analyzing this column students can begin to think about how to conduct an experiment to get the information they need to answer these items.

DAY TWO:

Class Discussion (10min)

- Teacher and students go over "Soil Collection Observation Worksheet" and teacher should point out the following concepts:
    - Each soil sample is different
    - There are many different uses for soils
    - Ways to classify soils
- Generate any new ideas for the **W** column.

Experiment Introduction (5min)

- Students get an introduction to experiment activities, and rubrics.

Experiment (50min)

- Students have already been broken down into groups of two and have collected soil samples.
- All groups should begin with the 'Fractionation' portion and then go onto the 'Percolation' experiments.
- If enough 100mL graduated cylinders are not available, students may use glass jars with lids, it will just be harder to record an accurate amount of each fraction. To alleviate this problem, use more soil when using the glass jars.
- Soil samples need to settle overnight.
- Some degree of teacher preparation is needed for the percolation tests to go smoothly. For both options the teacher needs to determine how much water should be percolated. These two factors can be adjusted to fit any time constraints. There are two choices for this experiment.
    - Students can explore how compaction effects percolation if there is not a great diversity of soil within close proximity of the school. The class will have to come up with a process for determining the relative amount of compaction of these different sites. Sites should include both high and low-traffic areas.
    - Students could also explore how soil composition effects percolation. To do this, students will also have to perform fractionation experiments on these soils to determine clay content. Again sites with varying clay and sand content would be best.
        - The students should carry out these fractionations. 1 or 2 samples per site is fine. These could be samples for student who failed to bring in their own sample.
- Teacher should demonstrate how to 'twist' can into soil to minimize alteration of the soil.

Group Work (10min)

- KWL Activity: Students work in groups of 4 – 6 and generate items to go under the **W** and **L** columns. Items for **L** column are saved for final group meeting and class discussion
- Any new items for the **W** column are put on the master sheet and each student's individual sheet.

Closing (10min)

- Any remaining questions can be answered.
- Ticket Out of the Door: 3-2-1 Activity
    - Students write down 3 things they learned today; 2 things that are still unclear to them, and 1 thing they didn't like.

THIRD DAY:

Opening Activity (20min)

- Demonstration of how to use the soil classification triangle.
- Discussion of how soil science is used everywhere.
    - Description of real-life applications of soil science, and how it affects us all.

Experiment: (40min)

- Distribute settled soil samples to students being careful not to disturb them too much.
- Help students, if needed, with soil classification triangle part.
- Instruct students where to discard soil solution.
- After soil fractionations have been analyzed and recorded, students should go onto the soil pH experiments.

Group Work and Closing (25min)

- Students work on developing the formula to determine the percent of each factor.
- Students in same groups of 4-6 as yesterday to generate ideas for **KWL**.
- In this final **KWL** activity the class and teacher will review the **K-W-L** process, how and why the experiment was designed. Students should lead a class-wide discussion for items to be put in the **L** column. This is also a way for teachers to measure comprehension to get an idea of what worked and didn't work.
- As part of the KWL activity, students will go back to their Soil Collection Observation Sheet and review what their soil's purpose is in the past, present, and future; and see if after characterizing their soil if it is the right type of soil for its intended purpose.

K	W	L
What we know about soil:	What we want to know:	What we learned:

NAME:_____ **DATE:**_____

SOIL COLLECTION OBSERVATION SHEET

Where was this soil taken from? (garden, field, forest, lawn, etc.)

What is the purpose of this soil? (past, present, and future)

Describe the texture of your soil. (i.e. sandy, coarse, fine, clumpy, etc.)

Describe the color of your soil sample.

Soil Characterization Experiments

Fractionation of Soil Sample

Equipment Checklist

- ❑ Soil – approximately 40ml
- ❑ 100ml graduated cylinder with rubber stopper
- ❑ Soil characterization triangle
- ❑ De-ionized water

Procedure Part One (15min)

1. Place 10mL of each soil sample into the 100mL graduated cylinder, then add 20mL of de-ionized water. Repeat this process until all soil is added. Water level should be around the 75mL mark, to leave room for you to mix it.
2. Shake, swirl, and gyrate, for 5min. Be very careful to release pressure by removing rubber stopper and not to spill or drop the cylinder and its contents.
3. Let soil sample settle overnight.

Procedure Part Two (20min) Second Day

1. After solution has settled determine the amount of each fraction(soil, clay, silt, and organic material) **Organic material may be floating. Record observations in lab journal.
2. Discard soil solution as directed.
3. Clean equipment and lab station.

Percolation Test

Equipment Checklist

- ❑ tin cans
- ❑ water
- ❑ tape
- ❑ stopwatch
- ❑ ruler

Procedure (35min)

1. Follow demonstration of tin can insertion by instructor.
2. Twist tin can gently into soil, going no deeper than determined by teacher. This depth should be marked with tape.
3. Once can is set, add predetermined amount of water and immediately begin recording time.
4. Stop the stopwatch when there is no water above the ground and record the total time.

Soil pH

Equipment Checklist

- ❑ pH meter
- ❑ pH strips
- ❑ Soil
- ❑ Distilled water
- ❑ 50mL test tube

Procedure (20 min) Second Day

1. Weigh out 5g of soil and place in a 50mL test tube.
2. Add 25mL of distilled water and shake vigorously for 10 minutes. Remember to remove stopper often to release built up pressure.
3. Using pH strips record pH of soil solution, this will correspond to the pH of your soil.
4. Repeat using the electric pH meter; be careful not to cross contaminate when measuring using.
5. Record observations and measurements.
6. Calibrate pH meter in between measurements using de-ionized water.
7. Clean up materials and lab area.

SOIL CHARACTERIZATION EXPERIMENT WORKSHEETS

Fractionation of Soil Sample

In the space provided, draw what your soil looked like after fractionation: (3pts)

If graduated cylinder was used, come up with a formula for determining the percent of each factor. If a glass jar was used instead, estimate percentage. (8pts)

_____ % Clay

_____ % Silt

_____ % Sand

_____ % Organic Matter

Now, using the soil characterization triangle, determine the classification of your soil sample. Begin with % silt and find the appropriate line. Do the same with the % sand. The point where these lines cross should match up with the remaining fraction of clay and fall within a classification area. (4pts)

What is the classification of your soil? _____

Percolation Test **(10pts)**

Degree of Compaction OR Soil Composition	High	Medium	Low	**Total Time Amount of Water**
		% Sand		
		%Silt		
		% Clay		

Soil pH **(5pts)**

pH determined by paper strips: _____

pH determined by pH meter: _____

soil pH scale category: _____

THINKING QUESTIONS

5 points each

1. What does each of the four factors contribute to soil?

2. Why would knowing the pH of your soil be important?

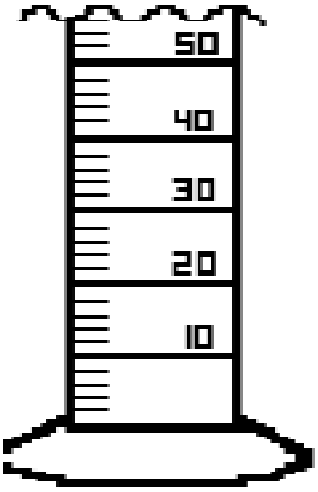
3. How does compaction or soil classification affect the percolation rate of the soil? Does this affect plant life and how?

4. What could the soil from your soil sample be best used for? Why?

SOIL CHARACTERIZATION EXPERIMENT WORKSHEETS

Fractionation of Soil Sample

In the space provided, draw what your soil looked like after fractionation: (3pts)



If graduated cylinder was used, come up with a formula for determining the percent of each factor. If a glass jar was used instead, estimate percentage. (8pts)

(ml fraction)/(ml total) = % Component

_____ % Clay

_____ % Silt

_____ % Sand

_____ % Organic Matter

Now, using the soil characterization triangle, determine the classification of your soil sample. Begin with % silt and find the appropriate line. Do the same with the % sand. The point where these lines cross should match up with the remaining fraction of clay and fall within a classification area. (4pts)

What is the classification of your soil? _____

Percolation Test **(10pts)**

Degree of Compaction	High Medium Low	**Total Time**	*300 seconds*
OR		**Amount of Water**	*100mL*
Soil Composition	% Sand		
	%Silt		
	% Clay		

Soil pH **(5pts)**

pH determined by paper strips: _____

pH determined by pH meter: _____

soil pH scale category: _____

THINKING QUESTIONS

5 points each

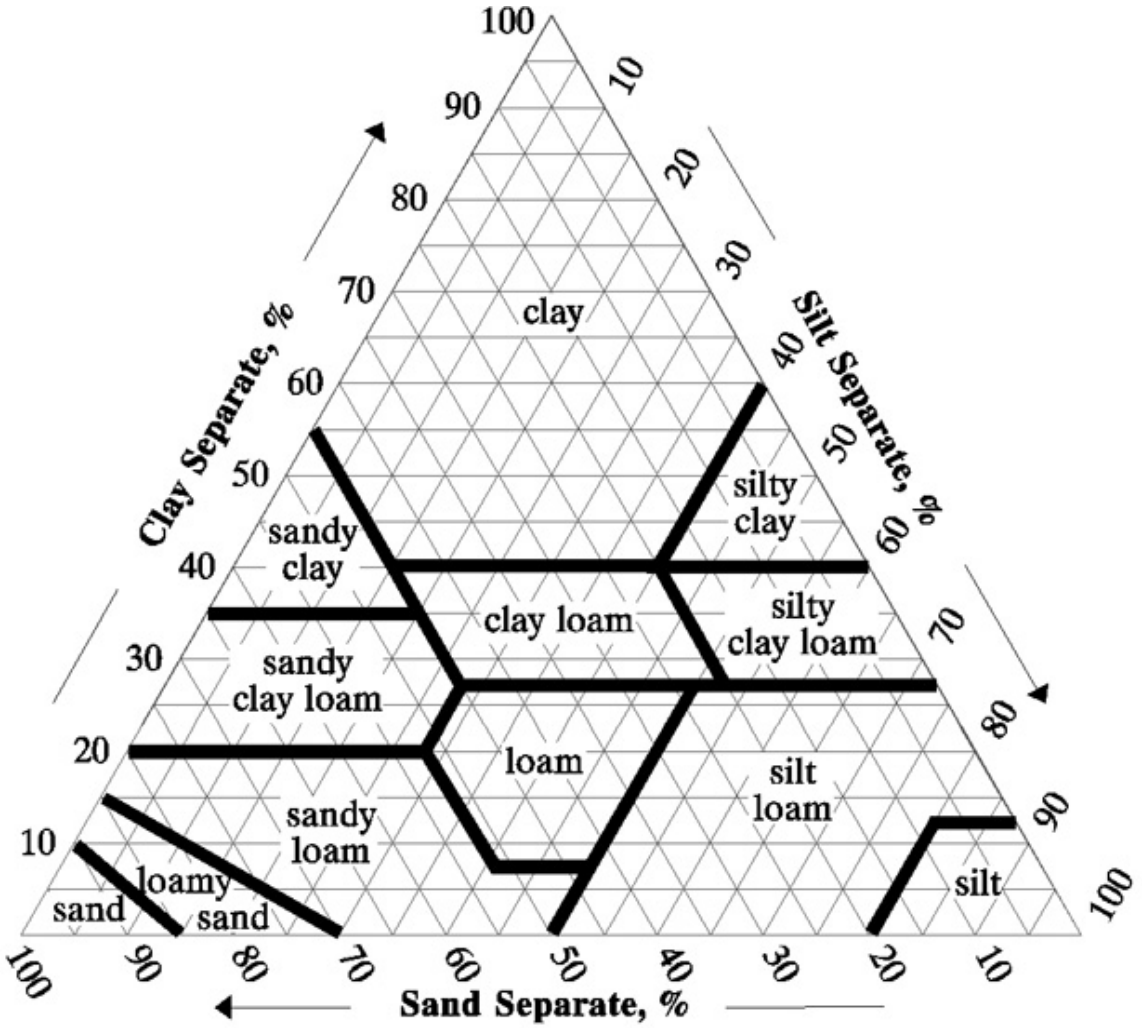
4. What does each of the four factors contribute to soil?
   sand – breaks up soil, speeds up percolation, allows water to move through soil, etc.
   clay – keeps soil together, retains water, slows down percolation, some nutrient value
   silt – ions, minerals, etc.
   organic material – contributes organic carbon and other nutrients to soil

5. Why would knowing the pH of your soil be important?
Knowing the pH of your soils is very important for determining which types of plants are going to grow best in it. Knowing soil pH is critical to both farmers and gardeners alike. Blueberry plants for instance prefer a slightly acidic soil.

6. How does compaction or soil classification affect the percolation rate of the soil? Does this affect plant life and how?
   By compacting the components of soil together, the spaces between those molecules decreases and it takes longer for water to percolate through the soil. It is also harder for the roots to grow in compacted soil. In compacted soil, there is not enough space for air and water to get to the roots.

Soils with high clay content are going to have slow percolation rates because clay retains water. Some plants my not like soils that are constantly wet. Sand is going to have the opposite effect on percolation.

7. What could the soil from your soil sample be best used for? Why?
My soil was a sandy clay. My parents were thinking about planting a garden here this spring. Right now this soil doesn't have enough silt or organic matter to make a suitable garden. With the addition of some peat moss or manure-type soil amendments, this soil would be better suited for a garden. Because it is relatively high in sand, it may not be the best soil to build something on, like a foundation for a house.



1. Begin by calculating the percentage of sand, clay, and silt of your soil. The percentage of organic matter should be omitted from the total for this portion of the lab.
2. Then take the percentage of sand on the bottom of the triangle and draw a line upwards and to the left (parallel with the right hand side of the triangle) at the exact percentage of your sample.
3. Next, take the percentage of clay from the left side of the triangle and starting at the correct percentage point, draw a line across (parallel with the bottom of the triangle) toward the right side of the triangle. It should cross the sand line at some point.
4. Finally, with the correct percentage of silt, draw a line parallel with the left side of the triangle downwards to the bottom. It should cross the other lines at the point where they met.
5. The intersection of all three lines will fall in one of the outlined areas on the grid, and this is your soil type.

Soil Characterization Module Rubric

Name:_____			Date:_____
Experiments	**Points Earned**	**Points Possible**	**Explanation of Points**
Soil sample collected outside of class AND on time		5	0 or 5 points awarded. Students will only receive 5 points if soil sample is **brought in on time.**
Soil Collection Observation Sheet complete		5	Must be done in conjunction with soil collection. 0 or 5 points awarded.
Directions followed accurately		3	3 points awarded if **all** directions are followed; 2 points for following **some** of them
Worksheets complete and correct		30	0-30 points may be assigned, depending upon points gained from answering questions completely
Thinking questions		20	0-20 points, each question is worth 5 points.
KWL			
Participated in class discussions		5	5 points for participating **all** the time, 3 points for **some** of the time, 0 points for **not** at all.
Participated in group discussions		5	Same as above.
Personal KWL completed and present		10	10 points for having **all** items on listed on Master KWL, 5-9 points for having **some**, 0 points for not doing one. Deduct 1 point for missing up to 4 items.
Totals:			
Total_____			